

POLYCYCLIC AROMATIC HYDROCARBONS IN ALLAN HILLS 84001 – IMPLICATIONS FROM TIME-OF-FLIGHT SECONDARY ION MASS SPECTROMETRY ANALYSES. T. Stephan and E. K. Jessberger, Institut für Planetologie/Interdisciplinary Center for Electron Microscopy and Microanalysis, Westfälische Wilhelms-Universität Münster, Wilhelm-Klemm-Str. 10, 48149 Münster, Germany, stephan@uni-muenster.de.

Introduction: The discovery of polycyclic aromatic hydrocarbons (PAHs) in the Martian meteorite Allan Hills 84001 initiated a controversial discussion about their origin. Proposed scenarios include biogenic as well as non-biogenic origins, terrestrial and extraterrestrial – Martian and non-Martian – sources [1–11]. With time-of-flight secondary ion mass spectrometry (TOF-SIMS) we have found PAHs to be omnipresent in polished sections of ALH 84001 [6–9]. Their lateral distribution suggests no correlation with carbonate, the carrier of proposed biomarkers. Nevertheless, since PAHs may be redistributed by the polishing process, it was doubted that polished sections are an adequate sample for studying the real distribution of organic compounds. To overcome this criticism, we extended our TOF-SIMS investigation to fractured surfaces.

Besides the localization of PAHs in ALH 84001, the study of secondary ion mass spectra may help to elucidate the origin of these organic molecules. In the past we therefore investigated two other meteorites, Murchison and Orgueil [9], as well as pure PAH substances, pentacene and coronene [8]. The mass spectra of the two carbonaceous chondrites strongly resemble those of ALH 84001 [9]. In the present study, we extended our investigation to anthracite coal as an example for a terrestrial (biogenic) PAH-containing sample.

Samples and Experimental Procedures: Several different areas on a fracture surface of ALH 84001 were investigated with TOF-SIMS. Although TOF-SIMS usually requires flat sample surfaces, also rough surfaces can be investigated. However, one has to be aware of topographic effects that can feign apparent enrichments or depletions [12].

As an example for terrestrial PAHs, we investigated a piece of anthracite coal. Here, a fresh fracture surface, almost perfectly flat, was produced. Anthracite coal was selected to minimize degassing from volatile components that would have hampered a proper analysis under ultra-high vacuum conditions.

Results: Imaging TOF-SIMS results from one carbonate-containing area of ALH 84001 are shown in Figs. 1 and 2. As in previous studies, no correlations between PAHs and carbonates were found here or in any other area of the same fracture surface. Variations in PAH secondary ion signals mainly result from topographic effects of this highly rugged area.

The comparison of PAHs from ALH 84001 with those from anthracite coal (Fig. 3) show a general en-

richment of PAHs with low H/C-ratios in the terrestrial sample, probably typical for anthracite coal. Heterocycles, although expected for biogenic PAHs [9], were not observed.

Discussion: The investigation of PAHs with TOF-SIMS on fracture surfaces of ALH 84001 confirmed earlier observations on polished surfaces, which showed that there is no correlation between PAHs and carbonates or proposed biomarkers within the carbonates. In contrary, some carbonates seem to be depleted in PAHs compared to the surrounding orthopyroxene.

The TOF-SIMS investigation of terrestrial PAHs showed so far no unambiguous way to discern these biogenic PAHs from those in the carbonaceous meteorites or ALH 84001.

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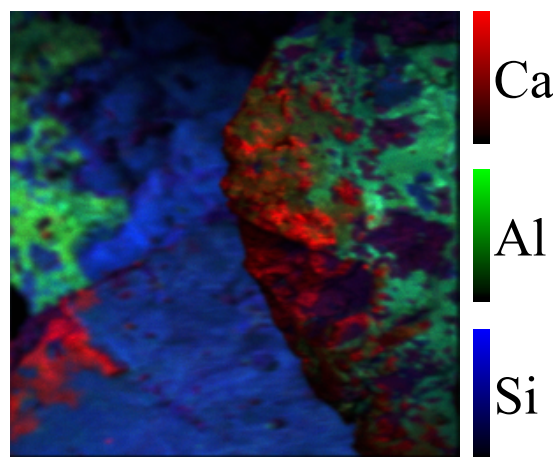


Fig. 1. RGB-image comprising the information of three secondary ion images shown in Fig. 2. Ca is indicative for carbonate. Al comes from feldspathic glass, whereas Si is predominant in orthopyroxene.

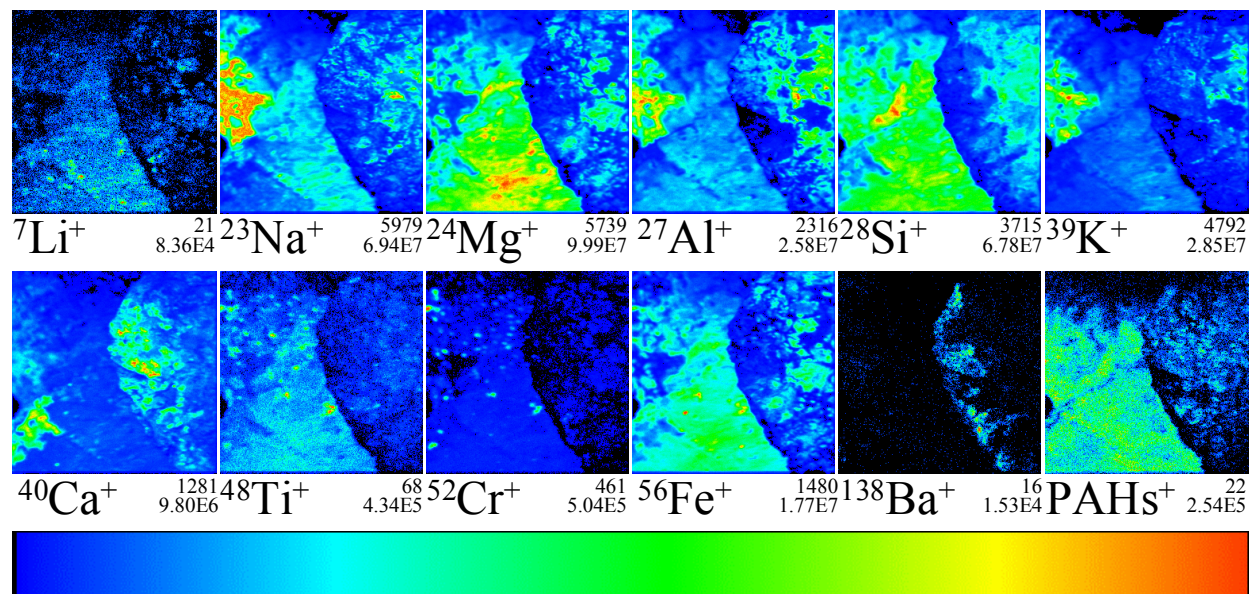


Fig. 2. TOF-SIMS images of positive secondary ions from a fracture surface of ALH 84001 (150×150 μm², 3200 shots/pixel, 256×256 pixels). The first number below each image gives the intensity in counts of the most intense pixel, shown in red. The second number is the integrated number of counts for the entire image. Besides the lateral distribution of several major, minor, and trace element ions, also PAHs are shown. From the latter image, no indication for PAH enrichments associated with carbonates or any other mineral phase is obvious. A general decrease of secondary ion intensity towards the upper right of the images is due to topographic effects.

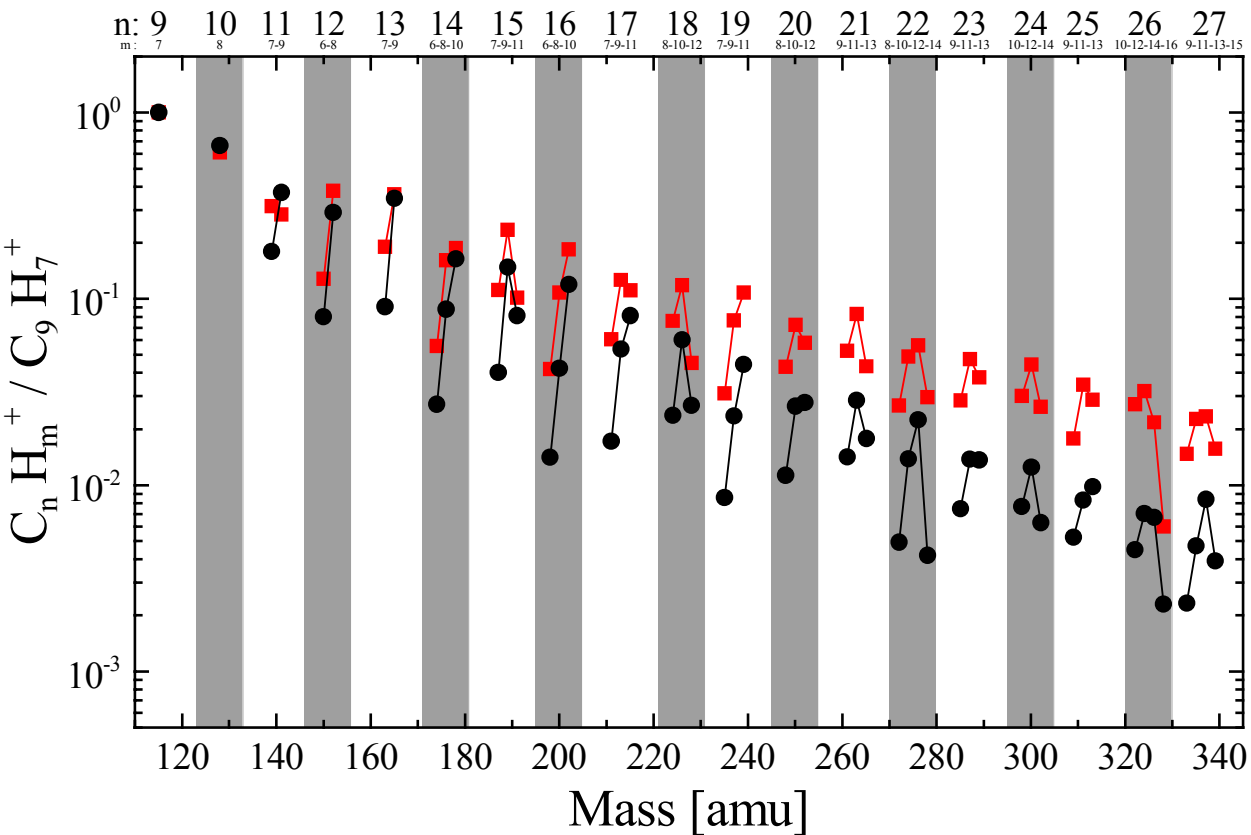


Fig. 3. Comparison of relative secondary ion intensities for various PAHs from ALH 84001 (black circles) with those from anthracite coal (red squares). The terrestrial sample is enriched in PAHs with lower H/C-ratios compared to the Martian meteorite.